Tributaries of Cottonwood Creek
Monitoring Report 2002

Developed for:

Idaho Soil Conservation District
Cottonwood Watershed Advisory Group
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Soil Conservation
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Technical Results Summary CDM-TCC-02

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Acknowledgements

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Executive Summary

This report summarizes the results from one year of monitoring the 303 (d) listed tributaries of Cottonwood Creek. Cottonwood Creek and Red Rock Creek were monitored concurrently by the Nez Perce Tribe at the time of this project. Dissolved oxygen exceedances only were observed on streams that almost or did go dry in mid summer. Temperature exceedances for salmonid spawning were observed in June and July just before the streams nearly went dry. No exceedance of pH was observed at any monitoring site. TSS and Turbidity only exceeded recommended levels during the spring runoff period. Phosphorus was positively correlated with sediment suggesting that phosphorus released into the water column was mobilized by sediment disturbance. The data suggest that grazing is a contributor to sediment mobilization in these tributaries. Nitrate+Nitrite exceedances were observed year round at SF Cottonwood and Stockney. Severe NO_3+NO_2 levels were observed at all Cottonwood Tributaries during spring runoff. It appears that fall application of anhydrous ammonia fertilizer is leading to the extremely high NO_3+NO_2 concentrations that are observed in the spring. Bacteria problems were greatest around May and June and the data suggest that cattle grazing is a contributor.

Introduction

Cottonwood Creek begins west of the City of Cottonwood and then flows 29 miles before draining into the South Fork of the Clearwater River. The watershed drains approximately 124,439 acres and has five main tributaries (Stockney, Shebang, Long Haul, SF Cottonwood, and Red Rock) (IDEQ 2000). Most of the data used for Total Maximum Daily Load (TMDL) development came from Resource Planning Unlimited (Gilmore 1998). Much of Cottonwood Creek and Red Rock Creek lie within tribal boundaries (58,373 acres or 47% of total watershed), this study performed monitoring on nontribal tributaries concurrent with tribal monitoring of tribal lands. This project collected further baseline data for TMDL development and implementation for nontribal tributaries of Cottonwood Creek (Stockney, Shebang, Long Haul, SF Cottonwood).

The primary nonpoint source pollutants for the tributaries of Cottonwood Creek are agricultural practices, runoff, and cattle grazing. Fine sediment analysis performed during TMDL development estimated load reductions for the five tributaries to be between 60 and 90% with a total suspended solids (TSS) target of 50 mg/L as a monthly average from January to May (IDEQ 2000).

Monitoring Program

Water quality monitoring was performed on the Tributaries of Cottonwood Creek (TCC) by the Idaho Association of Soil Conservation Districts (IASCD) from May 14, 2001 to May 20, 2002. One monitoring site near the mouth of South Fork of Cottonwood Creek, one site near the mouth of Long Haul Creek, one site near the mouth of Stockney Creek, and one site near the mouth of Shebang Creek were selected to represent watershed water quality with sampling occurring every two weeks. Parameters measured were total suspended solids (TSS), nitrate+nitrite (NO_3+NO_2), ammonia (NH_3), total phosphorus (TP) ortho-phosphate (OP), fecal coliform and *E. coli*.. Other measurements include flow, pH, specific conductance (Cond), total dissolved solids (TDS), dissolved oxygen (DO), % saturation (% Sat), turbidity (turb), and water temperature (temp). The data generated from this monitoring program will be used by IASCD, Idaho Soil Conservation Commission (ISCC), Idaho Soil Conservation District (ISCD), and the Cottonwood Watershed Advisory Group (CWAG) to determine loads within the stream, identify areas where best management practices (BMPs) would have the greatest benefit, provide baseline data prior to TMDL development, and identify changes as BMPs are implemented.

Site Descriptions

Monitoring site locations relative to the Cottonwood watershed are shown in Figure 1. Monitoring Station TCC-1 is located near the mouth of South Fork Cottonwood Creek near stream crossing of Highway 7. TCC-2 is located near the mouth of Long Haul Creek near the stream crossing with Day Road near Grangeville. Site TCC-3 is located near the mouth of Stockney Creek at the Kuby road crossing. TCC-4 is located near the mouth of Shebang Creek near the road crossing of Kube Road.

Methods

Water Quality

A representative depth-integrated sample was collected at each site by collecting approximately 4 liters of stream water with a DH-81. Water samples were collected with a one-liter Nalgene bottle and transferred into a 2.5-gallon polyethylene churn sample splitter. The polyethylene churn splitter was thoroughly rinsed with ambient water at each location prior to sample collection. The resultant composite sample was thoroughly homogenized before filling the appropriate sample containers. Ortho-phosphorus samples were filtered through a 0.45 µm GN-6 Gelman metricel filter. The resultant filtrate was transferred directly into sample bottle. The filtration unit was thoroughly rinsed with deionized water and equipped with a new 0.45 µm filter at each sampling location. Water samples requiring preservation (NO_2+NO_3, NH_3, TP, and OP) were transferred into preserved (H_2SO_4 pH <2) 500 mL sample containers. Water quality samples (TSS, NO_2+NO_3, NH_3, TP, and OP) were analyzed at the UIASL in Moscow, Idaho.

Bacteriological samples (fecal coliform and *E. coli*) were collected directly from the thalweg into sterile sample containers. The samples were shipped to Anatek Labs in Spokane, Washington for analysis. Most probable number (MPN) multiple tube fermentation was used to determine fecal coliform and *E. coli* levels in the water sample.

A list of parameters, sample sizes, preservation, holding times, and analytical methods are displayed in Table 1. All sample containers were labeled with waterproof markers with the following information: station location, sample identification, date of collection, and time of collection. Samples were placed on ice and transported to the laboratory the same day as collection. Chain-of-custody forms accompanied each sample shipment.

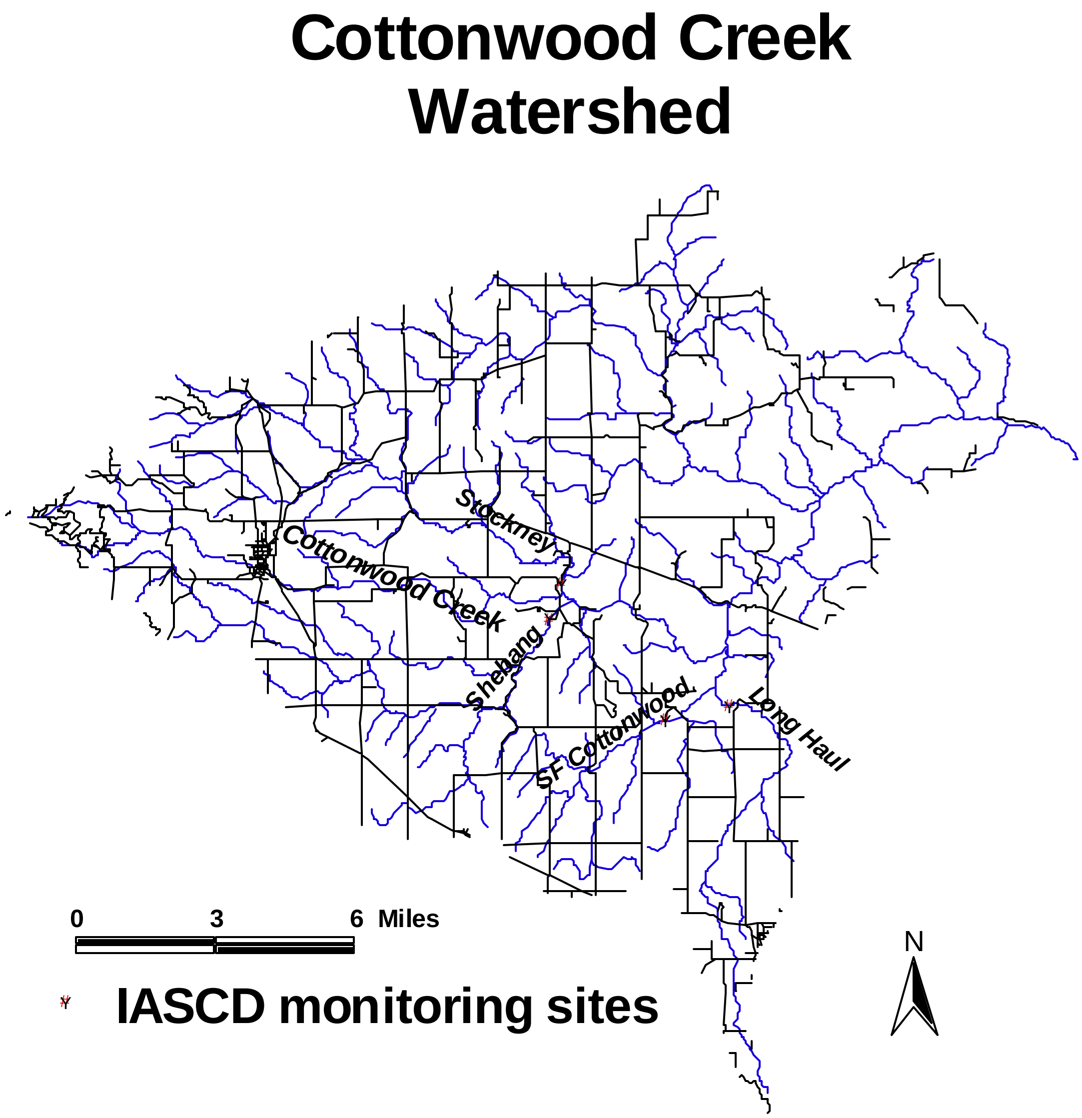

Figure 1. Tributaries of Cottonwood Creek study site locations.

Table 1. Water Quality Parameters

Parameters	Sample Size	Preservation	Holding Time	Method
Non Filterable Residue (TSS)	1L	Cool 4°C	7 Days	EPA 160.2
Nitrogen(NO_3+NO_2) Ammonia	60 mL	Cool 4°C, H_2SO_4 pH < 2	28 Days	EPA 353.2 EPA 350.1
Total Phosphorus	100 mL	Cool 4°C, H_2SO_4 pH < 2	28 Days	EPA 365.4
Ortho Phosphate	100 mL	Filtered , Cool 4°C	24 Hours	EPA 365.2
Fecal Coliform	100 mL	Cool 4°C	30 Hours	SM9221
Escherichia coli	100 mL	Cool 4°C	30 Hours	MPN

Field Measurements
At each location, field parameters for dissolved oxygen, specific conductance, pH, temperature, turbidity, and total dissolved solids were measured. Calibration of all field equipment will be in accordance with the manufacturer specifications. Field measurements, equipment and calibration techniques are shown in Table 2.

Table 2. Field Measurements

Parameters	Instrument	Calibration
Dissolved Oxygen	YSI Model 55	Ambient air calibration
Temperature	YSI Model 55 StowAway temperature logger Model XTI 02	Centigrade thermometer Centigrade thermometer
Conductance & TDS	Orion Model 115	Specific Conductance (25^{o}C standard)
pH	Orion Model 210A	Standard buffer (7,10) bracketing for linearity
Turbidity	Hach Model 2100P	Formazin Primary Standard

All field measurements were recorded in a field notebook along with any pertinent observations about the site, including weather conditions, flow rates, personnel on site, and any problems observed that might affect water quality.

Flow Measurements

Flow measurements were collected at each site using a Marsh McBirney Flow Mate Model 2000 flow meter. The six-tenths depth method (0.6 of the total depth from the surface of the water surface) was used. At each monitoring station, a transect line was established across the width of the stream at an angle perpendicular to the flow for the calculation of cross-sectional area. The discharge was computed by summing the products of the partial areas (partial sections) of the flow cross-sections and the average velocities for each of those sections. Stream discharge was reported as cubic feet per second (cfs).

Quality Assurance and Quality Control (QA/QC)

The UIASL utilizes methods approved and validated by the Environmental Protection Agency (EPA). A method validation process, including precision and accuracy performance evaluations and method detection limit studies, are required of UIASL Standard Methods. Method performance evaluations include quality control samples, analyzed with a batch to ensure sample data integrity. Internal laboratory spikes and duplicates are part of UIASL's quality assurance program. Laboratory QA/QC results generated from this project can be provided upon request.

QA/QC procedures from the field-sampling portion of this project included a duplicate and a blank sample (one set per sampling day). The field blanks consisted of laboratory-grade deionized water, transported to the field and poured off into the appropriate sample containers. The blank sample was used to determine the integrity of the field teams handling of samples, the condition of the sample containers and deionized water supplied by the laboratory and the accuracy of the laboratory methods. Duplicates were obtained by filling two sets of sample containers with homogenized composite water from the same sampling site. The duplicate and blank samples were not identified as such to laboratory personnel to ensure laboratory precision. Simple linear regression analysis was used to compare strength of relationships between samples with their respective duplicates (Appendix B)

Data Handling

All of the field data and analytical data generated from each survey was reviewed and submitted to ISDA for review. Each batch of data was reviewed to insure that all necessary observations, measurements, and analytical results have been properly recorded. The analytical results were evaluated for completeness and accuracy. Any suspected errors were investigated and resolved, if possible. The data was then stored electronically and made available to any interested entity upon request.

Results and Discussion

Descriptive data is presented in Table 3. This table includes maximum, minimum, and average values for each measured parameter as well as the number and percentage of sampling events that exceeded state water quality standards and EPA criteria.

Dissolved Oxygen

The State of Idaho standard for DO states that dissolved oxygen must exceed 6.0 mg/L for cold water biota at all times. DO concentrations only dropped below the recommended standard once at SF Cottonwood and Long Haul and four times at Shebang Creek (Figure 2, Table 3). DO concentrations only were found to exceed the standard just before the streams went dry in the summer (Figure 2). At Long Haul one value was recorded during mid-January that dropped below 2 mg/L, which could be due to equipment malfunction because of cold weather experienced that particular day (Figure 2).

Water Temperature

The State of Idaho water quality standard for temperature support of cold water biota is less than 22^{o}C. The Cottonwood Creek TMDL sets the temperature target at 9^{o}C from January 15-July 15 and below 19^{o}C all other times of the year (IDEQ 2000). No exceedance of the water temperature standard for instantaneous temperature (22^{o}C) was observed at any site with one exception at Shebang Creek, which happened in July just prior to the drying up of this stream (Figure 3, Table 3). Mean daily average temperature was observed over 22^{o}C around late July and early August at Long Haul and Shebang Creeks (Figure 3). All TCC monitoring sites exceeded the salmonid spawning temperature criteria during June and July just before the streams nearly went dry (Figure 3).

Specific Conductance and Total Dissolved Solids

No standards or criteria exist that set limits of conductance or TDS. Both conductance and TDS are within the higher range relative to other small streams in Idaho (Figure 4, Table 3). Considerable variation throughout the monitoring period was observed in both conductance and TDS at all sites (Figure 4). The highest values were observed during late summer and early winter months when groundwater contributes most surface flow (Figure 4). The measurements were lowest during spring runoff, which suggests that the groundwater is diluted by surface water, thus lowering values.

pH

The State of Idaho water quality standard for pH states that H^+ concentration must fall between 6.5 and 9.5. At no time during this monitoring period was pH observed to be outside of the acceptable range (Table 3).

Turbidity and Total Suspended Solids

The State of Idaho water quality standard for Turbidity states that measurements should not exceed 25 NTU for more than 10 consecutive days. This standard only was exceeded at every site during runoff events. The Cottonwood Creek TMDL set TSS targets at 50 mg/L as a monthly average (IDEQ 2000). TSS and turbidity measurements at all sites were very low with the exception of spring runoff (Figure 5, Figure 6, and Table 3). Maximum TSS values were 66 mg/L at SF Cottonwood, 66 mg/L at Long Haul, 32 mg/L at Stockney, and 64 mg/L at Shebang (Table 3). These were observed during runoff events at Stockney, SF Cottonwood, and Long Haul (Figure 6). High concentrations were observed in August at Long Haul and Shebang Creek, which was attributed to observed heavy instream cattle activity at the time of monitoring (Figure 6). Spearman Correlations showed significant

Table 3. Maximum, minimum, median, and average values for each measured parameter at IASCD Upper Lapwai Creek Monitoring locations. # exceedance/ year equals the number of sampling events when each respective value exceeded EPA or State of Idaho water quality standards and critera. % exceedance equals the percentage of sampling events when each respective value exceeded EPA or State of Idaho water quality standards and critera.

SF Cottonwood (TCC-1)	**D.O.**	**% Sat**	**Temp**	**Cond**	**TDS**	**pH**	**Turbidity**	**TSS**	**NH_3**	**NO_3+NO_2**	**TP**	**OP**	**F-Coli**	**E-Coli**	**Flow**
	(mg/L)	(%)	(^oC)	($\mu S/cm^2 @ 25^oC$)	(mg/L)	(H^+)	(NTU)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(#/100mL)	(#/100mL)	(cfs)
Maximum	14.1	124%	20.9	881.0	478.0	8.9	113.0	60.0	0.3	19.0	0.4	0.2	9000.0	9000.0	1.8
Minimum	5.7	50%	0.4	280.0	139.0	7.1	1.9	0.0	0.0	0.0	0.0	0.0	20.0	20.0	0.0
Average	10.0	27%	9.2	524.7	270.3	8.0	21.2	12.7	0.0	2.3	0.2	0.1	870.8	756.7	0.3
Median	9.9	90%	9.4	530.5	267.5	7.9	12.0	8.0	0.0	1.2	0.2	0.1	80.0	55.0	0.2
# exceedance	1.0		0.0			0.0	4.0			23.0	20.0	6.0	5.0	6.0	
% exceedance	3.7%		0.0%			0.0%	14.8%			85.2%	74.1%	22.2%	18.5%	22.2%	

Long Haul (TCC-2)	**D.O.**	**% Sat**	**Temp**	**Cond**	**TDS**	**pH**	**Turbidity**	**TSS**	**NH_3**	**NO_3+NO_2**	**TP**	**OP**	**F-Coli**	**E-Coli**	**Flow**
	(mg/L)	(%)	(^oC)	($\mu S/cm^2 @ 25^oC$)	(mg/L)	(H^+)	(NTU)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(#/100mL)	(#/100mL)	(cfs)
Maximum	14.6	108%	21.9	696.0	363.0	9.3	171.0	66.0	0.2	5.9	0.3	0.2	3000.0	3000.0	7.7
Minimum	2.0	12%	0.0	211.0	110.0	7.3	1.5	0.0	0.0	0.0	0.0	0.0	20.0	20.0	0.2
Average	10.7	27%	9.3	441.1	226.7	8.3	21.3	8.3	0.0	0.9	0.1	0.1	368.8	283.8	1.4
Median	10.9	101%	7.9	472.0	242.0	8.2	6.6	4.0	0.0	0.0	0.1	0.1	150.0	95.0	0.8
# exceedance	1.0		0.0			0.0	6.0			9.0	17.0	10.0	3.0	4.0	
% exceedance	3.7%		0.0%			0.0%	22.2%			33.3%	63.0%	37.0%	11.1%	14.8%	

Stockney (TCC-3)	**D.O.**	**% Sat**	**Temp**	**Cond**	**TDS**	**pH**	**Turbidity**	**TSS**	**NH_3**	**NO_3+NO_2**	**TP**	**OP**	**F-Coli**	**E-Coli**	**Flow**
	(mg/L)	(%)	(^oC)	($\mu S/cm^2 @ 25^oC$)	(mg/L)	(H^+)	(NTU)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(#/100mL)	(#/100mL)	(cfs)
Maximum	134.8	1350%	20.1	1070.0	584.0	8.5	124.0	32.0	0.3	9.9	0.3	0.3	2400.0	2400.0	26.5
Minimum	7.0	51%	0.0	570.0	124.0	7.0	3.8	0.0	0.0	0.0	0.1	0.0	20.0	20.0	0.0
Average	15.1	29%	8.4	619.5	322.8	8.0	17.2	10.1	0.0	2.1	0.2	0.1	354.1	350.0	3.1
Median	10.7	98%	7.7	698.0	345.0	8.0	10.3	8.0	0.0	0.9	0.2	0.1	70.0	55.0	1.4
# exceedance	0.0		0.0			0.0	3.0			20.0	21.0	12.0	3.0	5.0	
% exceedance	0.0%		0.0%			0.0%	11.1%			74.1%	77.8%	44.4%	11.1%	18.5%	

Shebang (TCC-4)	**D.O.**	**% Sat**	**Temp**	**Cond**	**TDS**	**pH**	**Turbidity**	**TSS**	**NH_3**	**NO_3+NO_2**	**TP**	**OP**	**F-Coli**	**E-Coli**	**Flow**
	(mg/L)	(%)	(^oC)	($\mu S/cm^2 @ 25^oC$)	(mg/L)	(H^+)	(NTU)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(#/100mL)	(#/100mL)	(cfs)
Maximum	14.3	132%	23.8	815.0	439.0	8.8	103.0	64.0	0.3	8.5	1.5	0.2	5000.0	5000.0	24.9
Minimum	2.1	21%	0.1	178.0	91.0	7.0	2.2	0.0	0.0	0.0	0.0	0.0	20.0	20.0	0.0
Average	9.7	28%	8.8	446.2	229.5	7.9	15.3	11.2	0.0	1.7	0.2	0.1	819.1	683.0	2.4
Median	10.2	96%	7.5	470.0	251.5	7.9	8.3	8.0	0.0	0.4	0.1	0.0	230.0	170.0	0.2
# exceedance	4.0		1.0			0.0	4.0			15.0	14.0	3.0	6.0	7.0	
% exceedance	14.8%		3.7%			0.0%	14.8%			55.6%	51.9%	11.1%	22.2%	25.9%	

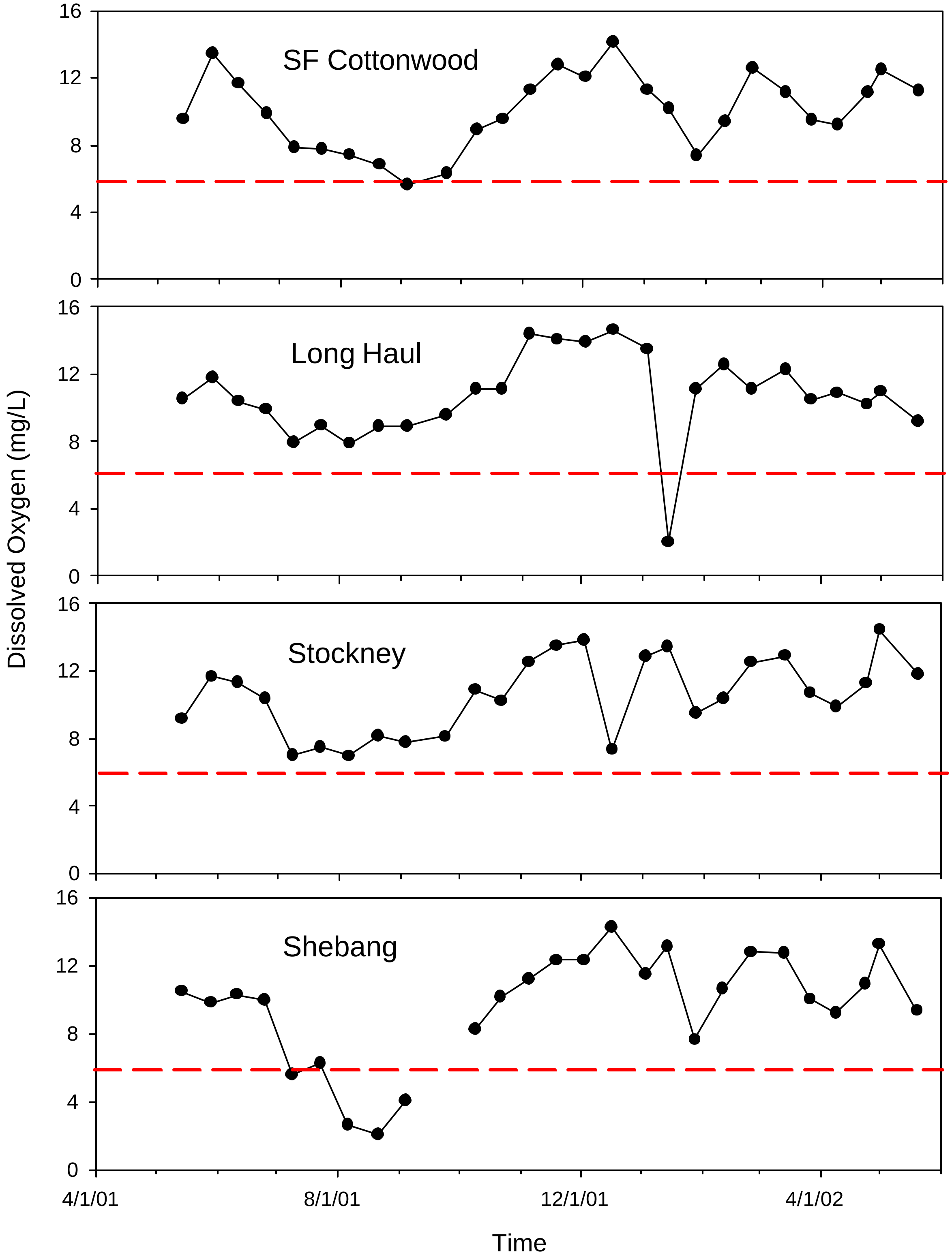

Figure 2. Dissolved oxygen concentrations collected from May 14, 2001 to May 21, 2002 at Cottonwood Tributaries.

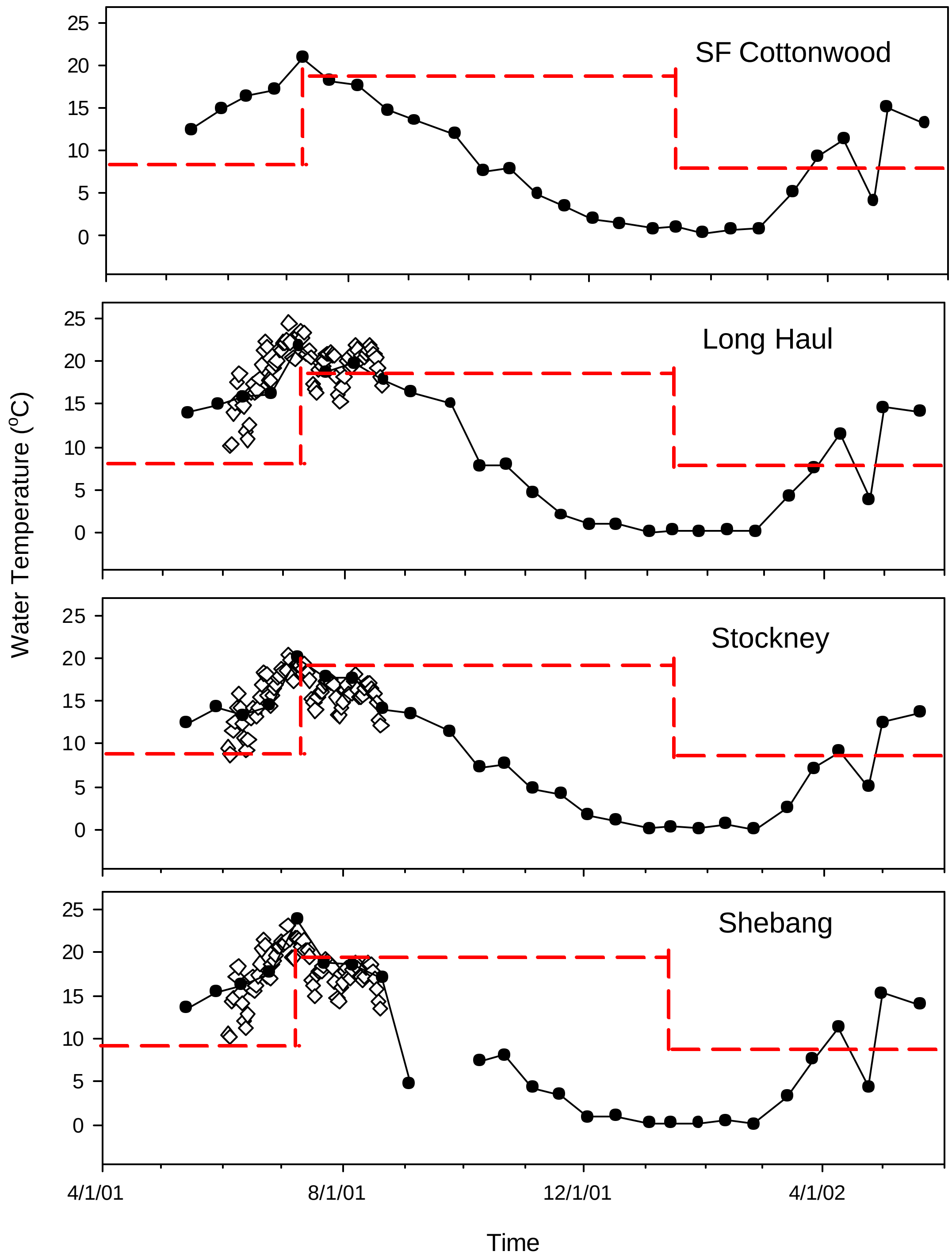

Figure 3. Instantaneous water temperature (solid black circle with line) and mean daily water temperature values (outlined diamonds) for each Cottonwood tributary. Mean daily averages were obtained from temperature loggers deployed during critical temperature period. Red line indicates the temperature target for salmonid spawning and the rest of the year.

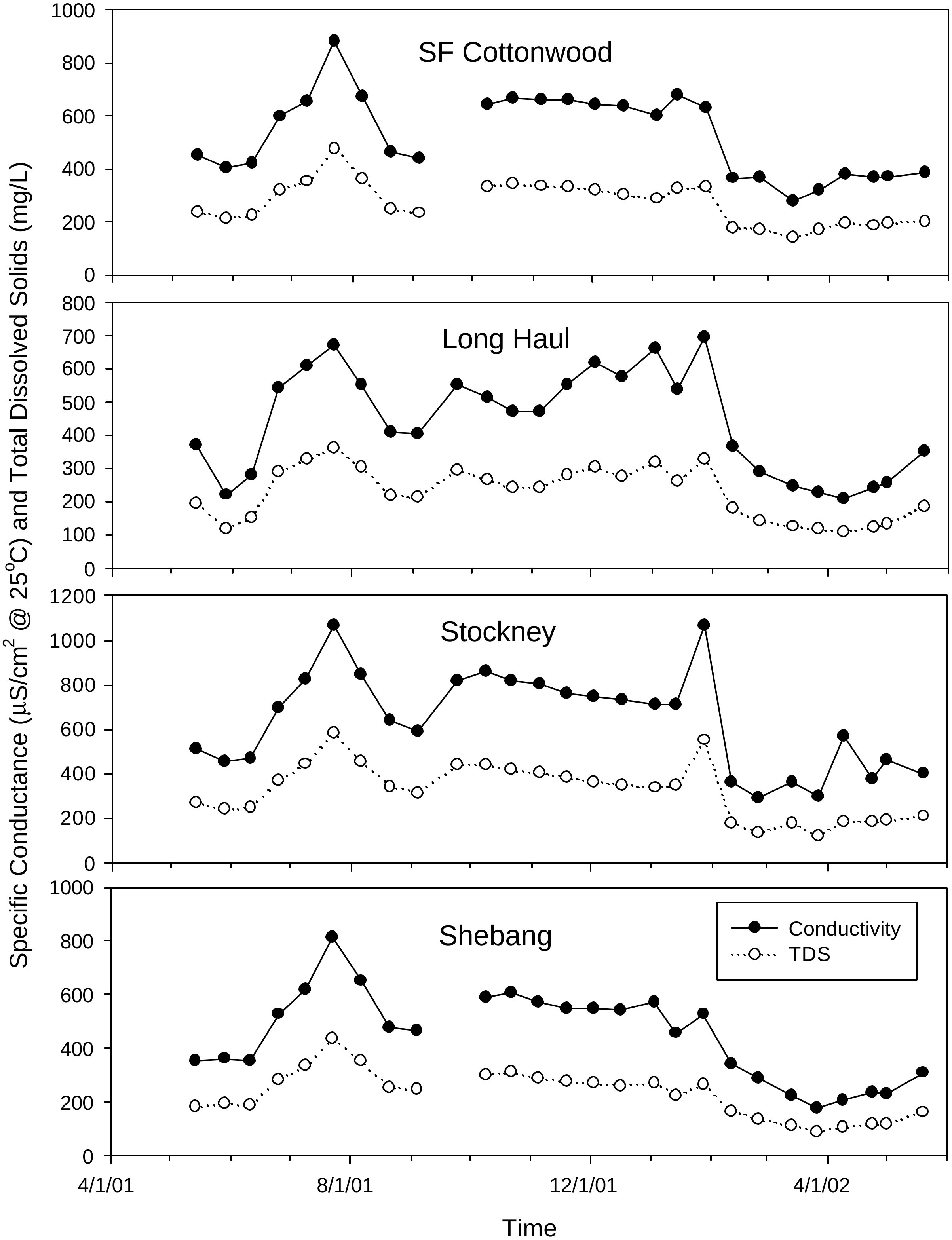

Figure 4. Specific conductance and total dissolved solids data collected at Cottonwood Tributaries from May 14, 2001 to May 21, 2002.

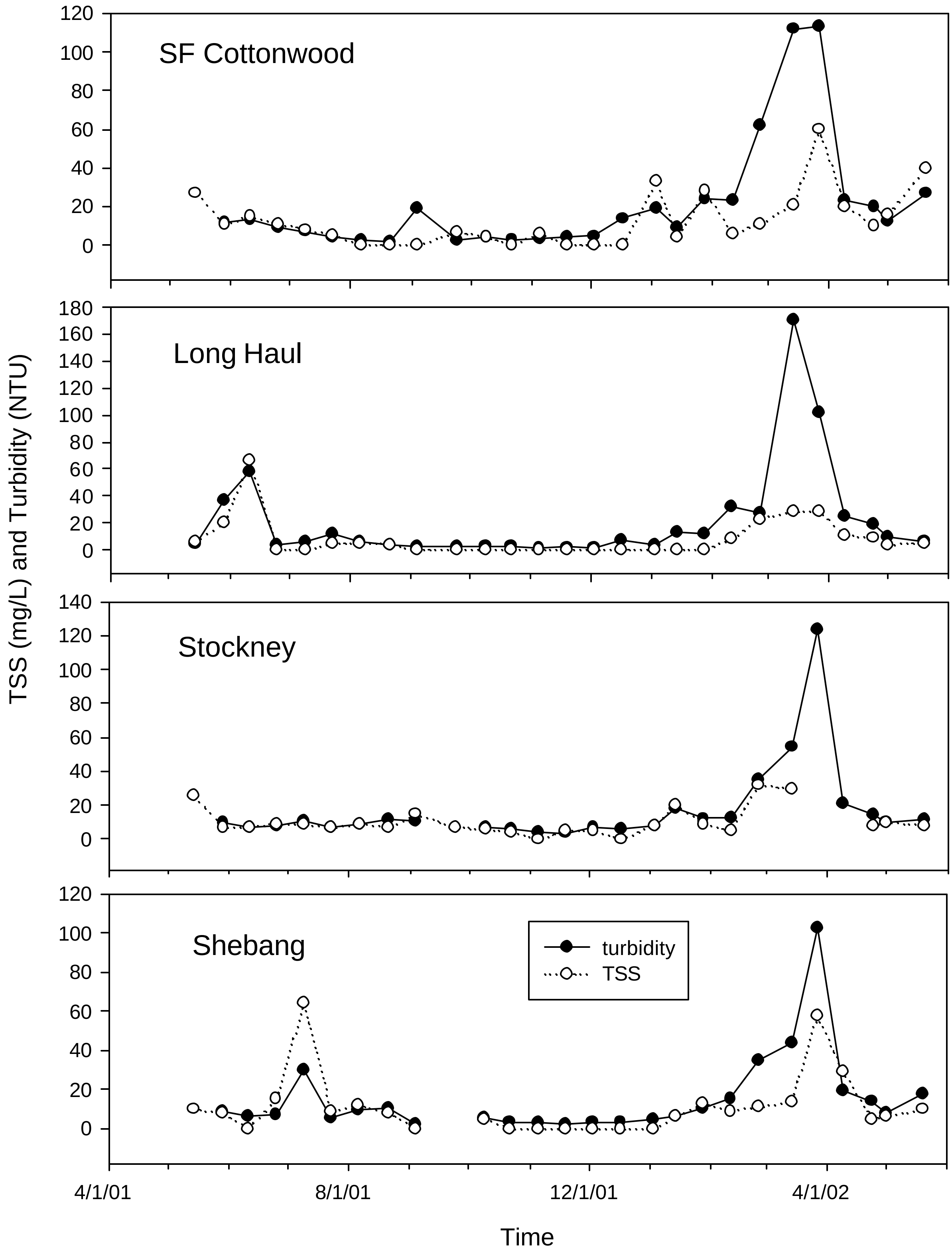

Figure 5. Turbidity and TSS data collected from Cottonwood Tributaries from May 14, 2001 to May 21, 2002.

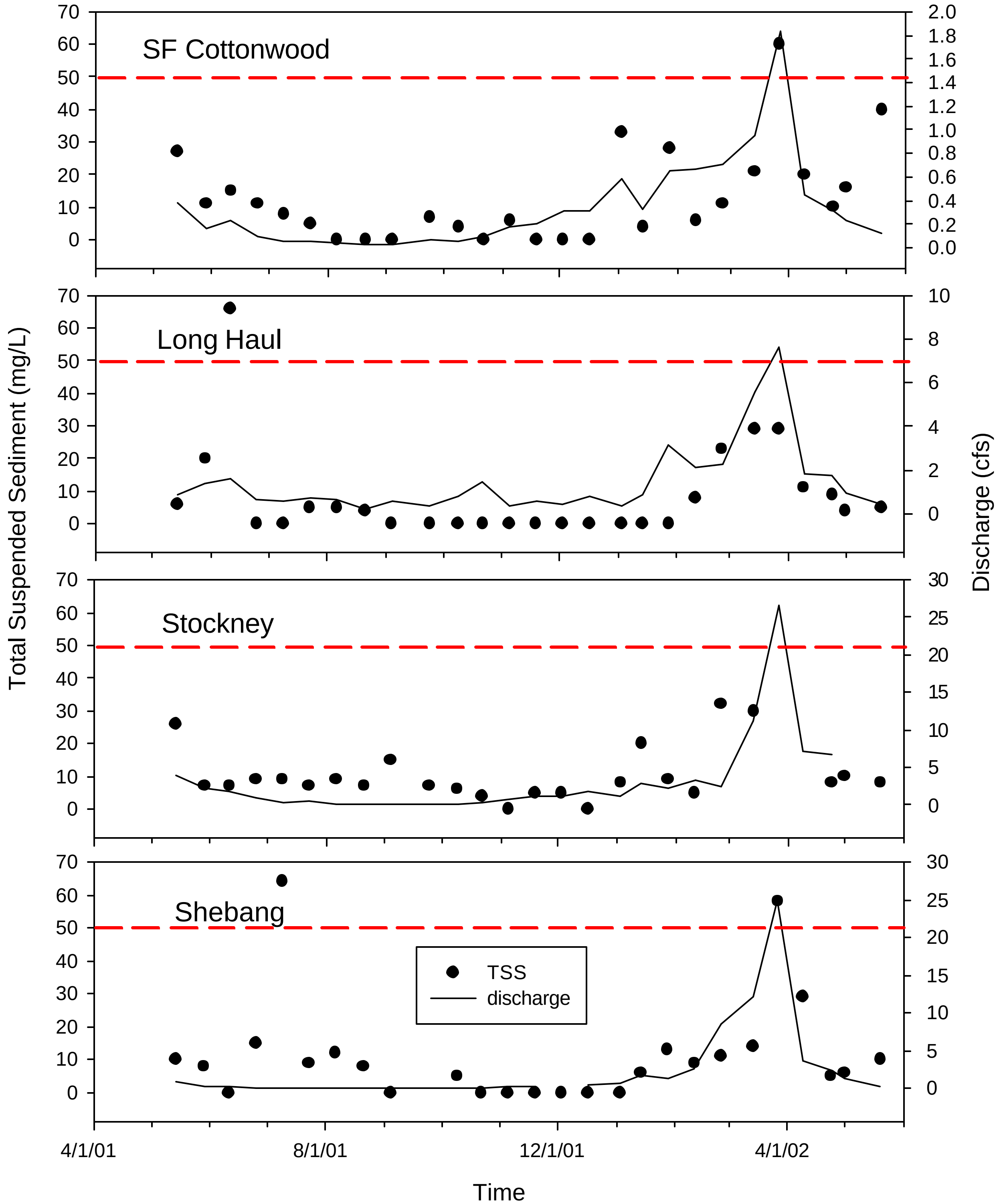

Figure 6. Total Suspended Solids plotted with stream discharge for Cottonwood Tributaries from May 14, 2001 to May 21, 2002. The red dashed line shows the TSS target of 50 mg/L on a monthly average. This data are instantaneous measurements.

associations ($p<0.001$) between TSS and turbidity at all TCC sites making turbidity a good surrogate for TSS in future monitoring. Strong correlations also were observed between TSS and TP which suggest that phosphorus is being released as sediment is mobilized.

Nitrate+Nitrite (NO_3+NO_2) and Ammonia (NH_3)

The EPA Gold Book warns that nitrate values in excess of 10 mg/L could be hazardous to young infants if ingested. All sites approached or exceeded 10 mg/L with the exception of TCC-2 during spring runoff (Figure 7, Table 3). The literature suggests that NO_3+NO_2 values in excess of 0.30 could contribute to excessive plant production and eutrophication. All NO_3+NO_2 concentrations were severely elevated at all monitoring sites during the spring runoff period (Figure 7, Table 3). At SF Cottonwood and Stockney Creeks NO_3+NO_2 concentrations were elevated year round, with an average value of 2.3 and a median value of 1.2 mg/L at SF cottonwood and 2.1 (average) and 0.9 mg/L (median) at Stockney (Figure 7, Table 3). Nitrogen concentrations at Long Haul and Shebang remained low with the exception of spring runoff (Figure 7). The large spikes observed during spring runoff at all sites suggests nitrogen-based fertilizer as the most probable contributor. Most farmers in the area are injecting anhydrous ammonia into the soil in the fall as part of their cropping rotations. Fertilizer producers encourage farmers to apply after moisture. However, if continued moisture and snow fall accumulate before the anhydrous form of ammonia can mineralize into the soil, the wet conditions form an anoxic barrier (lacking oxygen) at the soil surface. This anoxic condition promotes the chemical transformation of ammonia to nitrite and finally nitrate. These chemicals remain until runoff, when the nitrogen enters the water column.

Ammonia TMDL targets were set at 1.24 mg/L (November – April) and 0.16 mg/L May through October (IDEQ 2002). All TCC sites exceeded the May-Oct target of 0.16 mg/L one or two times during this time period (Figure 7). No exceedance of the 1.24 mg/L (Nov-April) was observed at any TCC study location (Figure 7).

Phosphorus (Total Phosphorus and Ortho-Phosphate)

Ortho-phosphate refers the dissolved or soluble portion of particles less than 0.45 µm. Total phosphorus refers to the total amount of P suspended in the water column (<0.45 + >0.45). The EPA Gold Book criterion for total phosphorus concentrations is 0.10 mg/L for streams or rivers not discharging directly into lakes or reservoirs. The Cottonwood Creek TMDL also set 0.10 mg/L as the target for total phosphorus (IDEQ 2000). Significant positive associations ($p<0.05$) were found between TSS and TP at all monitoring locations suggesting that phosphorus is released as sediment is being mobilized. This explains increases in phosphorus observed during the spring runoff period but not elevated values observed during June and July (Figure 8). Grazing of cattle in riparian areas also could contribute to increases in phosphorus as well as mobilize sediment, resulting in a release of phosphorus into the water column. During June and July cattle were present at all sites and had complete access to the stream.

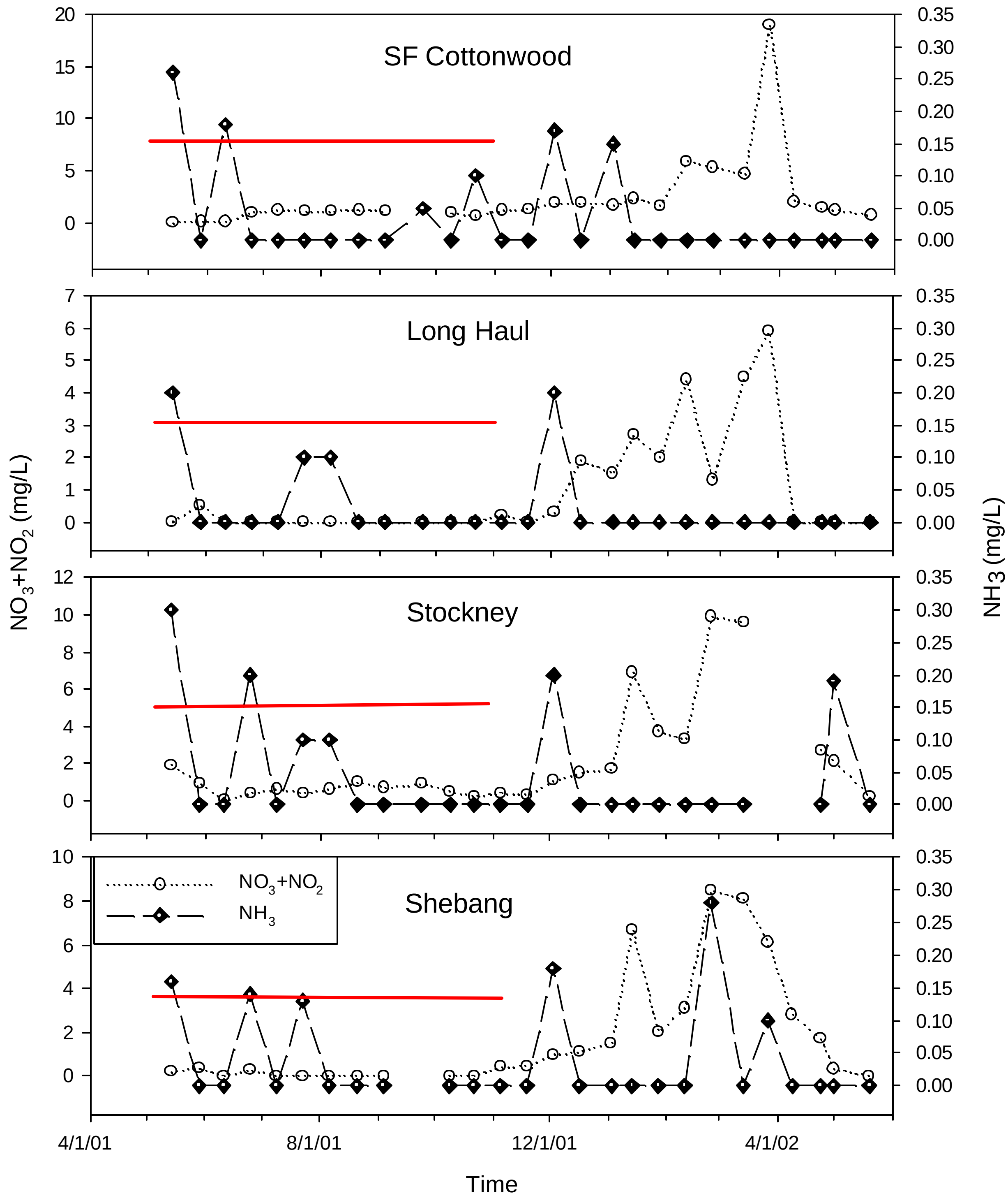

Figure 7. Nitrate + Nitrite concentrations for Cottonwood Tributaries from May 14, 2001 to May 21, 2002. The partial red solid line shows the the ammonia target from the Cottonwood TMDL of 0.16 mg/L (May-Oct).

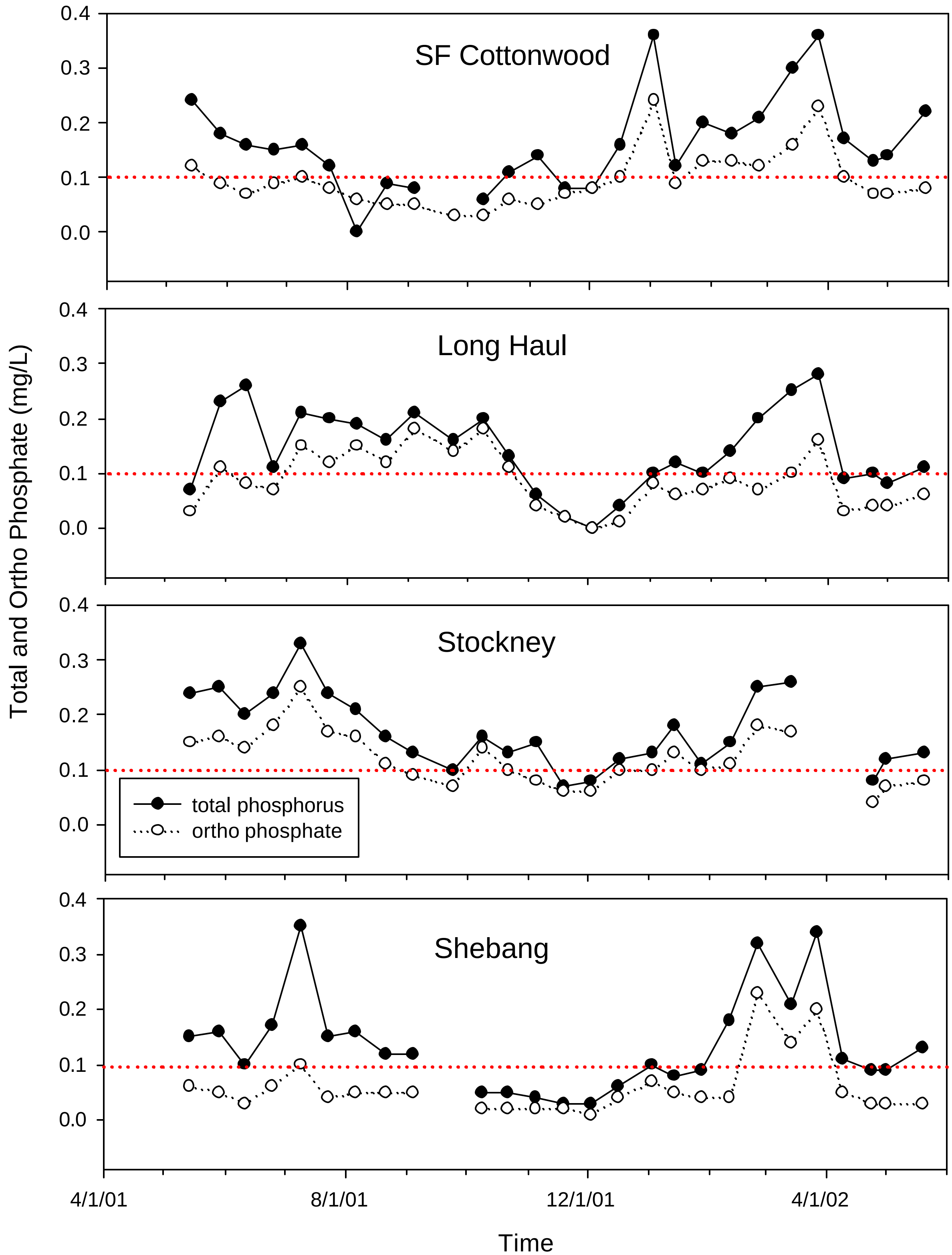

Figure 8. Total phosphorus and ortho-phosphate concentrations collected for Cottonwood Tributaries from May 14, 2001 to May 21, 2002.

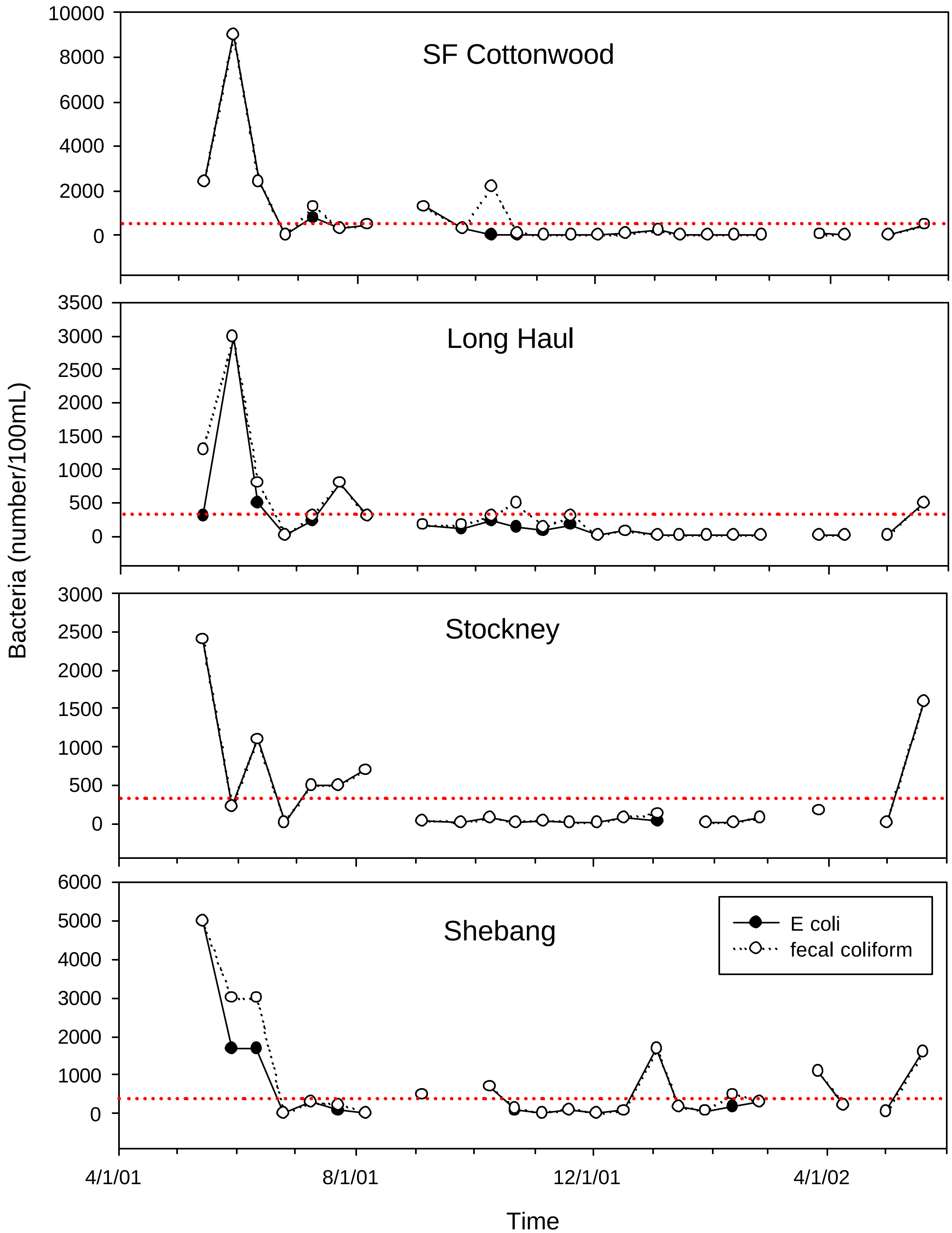

Figure 9. Fecal coliform and E. coli concentrations for Cottonwood tributaries project. Red line indicates E. coli standard for primary contact of 406 ind/100mL.

Bacteria (*E. coli* and fecal coliform)

The standard for *E. coli* is that concentrations should not exceed 126 organisms/100 mL, which should be based on the geometric mean (5 samples collected over a 30 day period). The *E. coli* standard for primary contact is not to exceed 406 organisms/100 mL at any time. Bacteria concentrations for E. coli only exceeded the recommended standard during May and early June except for one event in September at SF Cottonwood and one event January at Shebang Creek (Figure 9, Table 3). Cattle grazing at all sites appear to be the mechanism responsible for the exceedance levels.

Historic Data Comparison

Comparisons of Gilmore data collected at the same sites in 1998 was made for TSS, TP, and NO_3+NO_2 (Figure 10 abc). These comparisons are noted to be weak because the Gilmore data was collected by Sigma samplers and IASCD data was collected instantaneously. However, average and maximum values over the entire sampling period for each data set should give an idea as to any water quality improvements over time. TSS concentrations were significantly lower in 2001 at all sites (Figure 10a). Total phosphorus also were considerable less in 2001 at all sites except for Shebang Creek (Figure 10b). Very little change was seen in Nitrate+Nitrite between the two data sets (Figure 10c). Gilmore (1998) found that precipitation was 128% above average from Oct 96-Sept 97, but only 58% of normal for the initial months of 1998. Farmers in the area with the exception of one individual are using no till and direct seed technology for their plantings (Scott Wasem personal communication). Since 2001-2002 has been a below average precipitation year, it is very hard to say that the observed improvements in water quality are related to improved farm practices rather than climatic variation.

Conclusions

The monitoring program for Cottonwood Creek Tributaries was successfully carried out as planned. Protocols were followed, QA/QC standards were met (Appendix B), and specific information per TMDL parameter for each subwatershed was collected. Dissolved oxygen exceedances only were observed on streams that almost or did go dry in mid summer. Instantaneous water temperature standards were met at all sites with only one exception at Shebang Creek, which went completely dry. All sites exceeded the salmonid spawning temperature standard during June and July. All of these streams had discharges of 1 cfs or less during this time. No exceedance of pH was observed at any TCC monitoring site. Observations and the data suggest that grazing is a contributor to sediment mobilization. Dryland agriculture and roads also are potential contributors. TSS and Turbidity only exceeded recommended levels during the spring runoff period. Significant correlations ($p<0.05$) between TSS and TP suggests that phosphorus released into the water column was mobilized by sediment disturbance. Nitrate+Nitrite exceedances were observed year round at SF Cottonwood and Stockney. All Cottonwood Tributaries experienced severe NO_3+NO_2 concentrations during spring runoff. It appears that fall application of anhydrous ammonia fertilizer is leading to the extremely high NO_3+NO_2 concentrations that are observed in the spring. Bacteria problems were greatest around May and June and the data suggest that grazing is a contributor because cattle were observed in the streams during this time period. There are a few scattered homes in the areas that could be potential contributors.

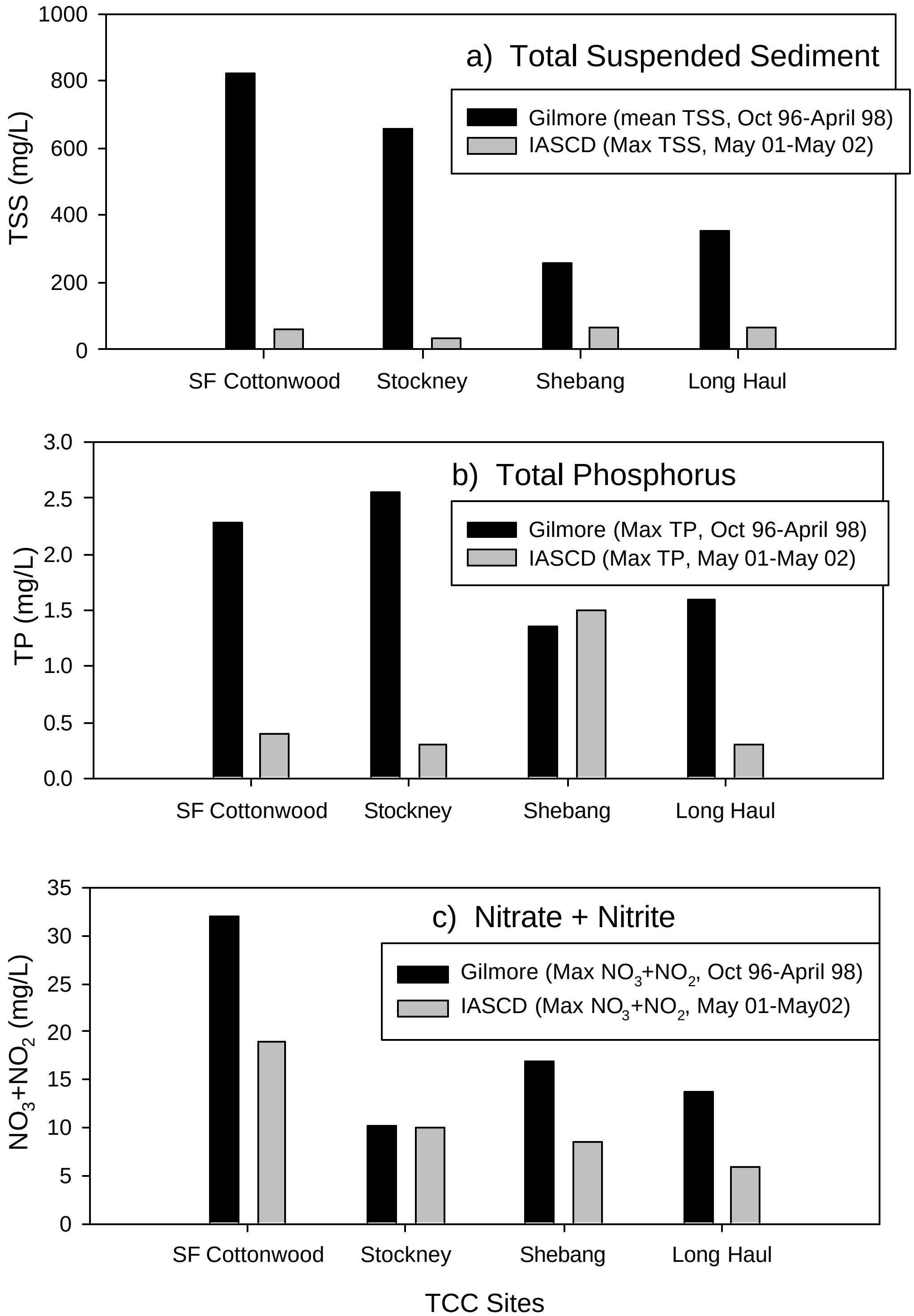

Figure 10. Comparisons of current IASCD monitoring data to past Gilmore 98 data for Cottonwood Tributaries for TSS, TP, and NO_3+NO_2)

Recommendations

Exclusion of the cattle from waterways would improve stream water temperature, nutrient, and bacteria levels. Bacterial DNA testing could determine what organism (cattle, human, or waterfowl) is responsible for elevated *E. coli* concentrations. I recommend fencing of stream, offsite watering of cattle, and riparian stream plantings. The Natural Resources Conservation Service (NRCS) and the ISCC should work with local landowners to repair stream conditions dealing with grazing and to develop a nutrient management plan for the area. Further study to determine how efficient nitrogen based fertilizer is on fields should be performed. Most farmers are using anhydrous ammonia because it is the least expensive form available. However, if they are required to overapply in order to meet fertilization requirements, then another form might be more practical in terms of efficiency and thus economically. I recommend that agencies (local, state, and federal) join together to study the overwinter effects of nitrogen fertilizer in North Idaho. Several locations on the Camas Prairie have been identified by the DEQ as having elevated nitrate concentrations in the groundwater. Further study should focus on the possible sources of nitrogen based contamination into the aquifer. Fertilizer and septic systems could be contributing to this problem and each should be studied.

References

EPA method 365.4-Methods for Chemical Analysis of Water and Wastes, US Environmental Protection Agency, Cincinnati, OH. 1983.

EPA method 365.2-Methods for Chemical Analysis of Water and Wastes, US Environmental Protection Agency, Cincinnati, OH. 1983.

EPA method 353.2-Methods for Chemical Analysis of Water and Wastes, US Environmental Protection Agency, Cincinnati, OH. 1983.

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EPA method 350.1-Methods for Chemical Analysis of Water and Wastes, US Environmental Protection Agency, Cincinnati, OH. 1983.

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Gilmore, Shelly. 1998. Cottonwood Creek Monitoring Program Final Report. Prepared for the Idaho Soil and Water Conservation District by Shelly Gilmore of Resource Planning Unlimited. Moscow, Idaho.

Idaho Department of Environmental Quality (IDEQ), 2000. Cottonwood Creek Total Maximum Daily Load (TMDL).

Appendix A Tributaries of Cottonwood Creek raw data

ttonwood Creek

TCC-1

DATE		TCC1-DO	TCC1-SAT	CC1-TEMI	CC1-CONI	TCC1-TDS	TCC1-PH	CC1-TURI	TCC1-TSS	TSS1-NH3	TCC1-NN	TCC1-TP	TCC1-OP	TCC1-FC	TCC1-EC	TCC1-Q
Date	**Time**	**D.O.**	**% Sat**	**Temp**	**Cond**	**TDS**	**pH**	**Turbidity**	**TSS**	**NH_3**	**NO_2+NO_3**	**TP**	**OP**	**F-Coli**	**E-Coli**	**Flow**
		(ppm)		(^oC)	(uS)	(mg)		(NTU)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	Coli/100mL	Coli/100mL	(cfs)
5/14/01	13:30	9.56	89.9%	12.5	453.0	239.0	7.89		27.0	0.260	BDL	0.240	0.120	2400	2400	0.38
5/29/01	10:28	13.44	133.2%	14.9	403.0	214.0	8.33	11.4	11.0	BDL	0.093	0.180	0.085	9000	9000	0.16
6/11/01	11:11	11.66	118.9%	16.5	422.0	223.0	8.20	13.0	15.0	0.18	0.1	0.160	0.070	2400	2400	0.23
6/25/01	10:47	9.88	102.9%	17.2	598.0	320.0	7.81	8.9	11.0	BDL	1	0.150	0.088	20.0	20.0	0.09
7/9/01	10:54	7.84	87.8%	20.9	655.0	353.0	7.81	7.1	8.0	BDL	1.200	0.160	0.100	1300.00	800.00	0.05
7/23/01	10:29	7.78	82.3%	18.2	881.0	478.0	7.83	4.5	5.0	BDL	1.100	0.120	0.075	300	300	0.06
8/6/01	11:04	7.41	77.8%	17.7	673.0	363.0	7.30	2.7	BDL	BDL	1.100	BDL	0.056	500	500	0.04
8/21/01	12:07	6.83	67.4%	14.8	463.0	247.0	7.80	1.9	BDL	BDL	1.200	0.089	0.052			0.03
9/4/01	11:30	5.65	54.4%	13.6	438.0	234.0	7.92	19.4	BDL	BDL	1.100	0.080	0.053	1300	1300	0.03
9/24/01	11:26	6.33	58.8%	12			7.72	2.6	7.0	0.051			0.034	300	300	0.07
10/9/01	11:25	8.93	74.7%	7.6	644.0	334.0	7.09	4.3	4.0	BDL	0.920	0.062	0.034	2200	20	0.06
10/22/01	11:07	9.56	80.4%	7.9	665.0	345.0	8.30	3.0	BDL	0.100	0.640	0.110	0.063	80	20	0.10
11/5/01	10:08	11.27	88.1%	4.9	660.0	335.0	7.97	3.08	6.0	BDL	1.200	0.140	0.052	<20	<20	0.18
11/19/01	10:20	12.77	96.3%	3.5	662.0	333.0	8.06	4.5	BDL	BDL	1.300	0.082	0.069	<20	<20	0.20
12/3/01	9:57	12.05	87.1%	2	642.0	319.0	8.92	4.7	BDL	0.170	1.900	0.083	0.077	<20	<20	0.31
12/17/01	10:45	14.12	101.9%	1.5	634.0	303.0	8.77	13.8	BDL	BDL	1.900	0.160	0.099	80.00	80.000	0.32125
1/3/02	10:40	11.29	78.8%	0.9	602.0	288.0	7.80	19.3	33.0	0.150	1.700	0.360	0.240	230.00	230.000	0.58
1/14/02	10:15	10.18	71.9%	1.1	676.0	325.0	7.92	9.4	4.0	BDL	2.300	0.120	0.090	<20	<20	0.33
1/28/02	11:00	7.40	51.2%	0.4	631.0	332.0	7.53	24.4	28.0	BDL	1.600	0.200	0.130	40.00	40.000	0.65
2/11/02	10:40	9.4	66.1	0.8	365	176	7.38	23.2	6	BDL	5.9	0.18	0.13	40	40	0.66585
2/25/02	10:50	12.61	88.5	0.9	369	174	8.88	61.8	11	BDL	5.3	0.21	0.12	20	20	0.706
3/14/02	14:20	11.11	86.7	5.1	280	139	8.15	112	21	BDL	4.7	0.3	0.16			0.9491
3/27/02	12:30	9.47	82.7	9.4	319	172	8.12	113	60	BDL	19	0.36	0.23	70	70	1.8345
4/9/02	12:35	9.2	84.3	11.4	379	197	8.4	23.3	20	BDL	2	0.17	0.1	20	20	0.4468
4/24/02	9:04	11.14	85.1	4.1	370	186	7.9	19.7	10	BDL	1.4	0.13	0.071			0.321
5/1/02	11:38	12.5	124.4	15.1	371	197	8.15	12.5	16	BDL	1.2	0.14	0.065	20	20	0.23475
5/20/02	11:04	11.24	101.2	13.2	386	202	8.2	27	40	BDL	0.74	0.22	0.079	500	500	0.126

ng Haul Creek

TCC-2

DATE		TCC2-DO	TCC2-SAT	TCC2-TEMI	TCC2-CONI	TCC2-TDS	TCC2-PH	TCC2-TURE	TCC2-TSS	TSS1-NH3	TCC2-NN	TCC2-TP	TCC2-OP	TCC2-FC	TCC2-EC	TCC2-Q
Date	**Time**	**D.O.**	**% Sat**	**Temp**	**Cond**	**TDS**	**pH**	**Turbidity**	**TSS**	**NH_3**	**NO_2+NO_3**	**TP**	**OP**	**F-Coli**	**E-Coli**	**Flow**
		(ppm)		(^{o}C)	(uS)	(mg)		(NTU)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	Coli/100mL	Coli/100mL	(cfs)
5/14/01	10:33	10.53	102.2%	14	371.0	196.0	8.23	4.2	6.0	0.2	BDL	0.067	0.029	1300	300	0.85
5/29/01	9:34	11.81	117.0%	14.9	221.0	117.0	8.18	37.2	20.0	BDL	0.5	0.230	0.110	3000	3000	1.37
6/11/01	10:13	10.37	104.7%	15.9	283.0	154.0	8.38	58.4	66.0	BDL	BDL	0.260	0.080	800	500	1.59
6/25/01	9:40	9.90	100.6%	16.2	544.0	291.0	8.21	3.5	BDL	BDL	BDL	0.110	0.074	20.0	20.0	0.62
7/9/01	10:11	7.91	90.9%	21.9	609.0	328.0	8.21	5.9	BDL	BDL	BDL	0.210	0.150	300	230.00	0.61
7/23/01	9:46	8.93	95.8%	18.8	670.0	363.0	8.16	12.3	5.0	0.1	BDL	0.200	0.120	800.00	800	0.75
8/6/01	10:20	7.88	86.0%	19.8	551.0	303.0	8.30	6.2	5.0	0.1	BDL	0.190	0.150	300	300	0.67
8/21/01	11:05	8.92	94.4%	17.9	409.0	218.0	8.14	3.9	4.0	BDL	BDL	0.160	0.120			0.23
9/4/01	10:45	8.89	88.9%	16.4	403.0	216.0	7.77	2.6	BDL	BDL	BDL	0.210	0.180	170	170	0.59
9/24/01	10:50	9.54	95.0%	15.1	553.0	297.0	7.94	2.4	BDL	BDL	BDL	0.160	0.140	170	110	0.38
10/9/01	10:49	11.09	93.4%	7.8	512.0	265.0	7.88	3.1	BDL	BDL	BDL	0.200	0.180	300	230	0.79
10/22/01	10:37	11.10	93.5%	7.9	472.0	242.0	8.82	3.0	BDL	BDL	BDL	0.130	0.110	500	140	1.50
11/5/01	9:37	14.39	11.8%	4.7	472.0	244.0	8.20	1.51	BDL	BDL	0.2	0.062	0.036	130	80	0.35
11/19/01	9:27	14.07	103.9%	2.01	552.0	281.0	8.06	1.9	BDL	BDL	BDL	0.020	0.018	300	170	0.55
12/3/01	9:19	13.94	97.9%	0.9	620.0	303.0	8.96	1.8	BDL	0.2	0.3	BDL	BDL	<20	<20	0.41
12/17/01	9:43	14.62	102.3%	0.9	576.0	277.0	8.38	7.0	BDL	BDL	1.9	0.038	0.012	80.00	80.000	0.82
1/3/02	10:20	13.49	92.0%	0	663.0	321.0	8.18	3.5	BDL	BDL	1.5	0.100	0.076	20.00	20.000	0.39
1/14/02	9:45	2.01	82.5%	0.2	539.0	261.0	8.40	13.0	BDL	BDL	2.7	0.120	0.062	<20	<20	0.86
1/28/02	10:30	11.11	76.4%	0.1	696.0	328.0	8.23	12.4	BDL	BDL	2.0	0.097	0.066	20.00	<20	3.13
2/11/02	10:30	12.55	86.4	0.2	366	179	9	32	8	BDL	4.4	0.14	0.09	20	20	2.1172
2/25/02	10:30	11.08	76	0.1	292	141	8.89	27.1	23	BDL	1.3	0.2	0.072	<20	<20	2.26965
3/14/02	13:47	12.25	93.8	4.2	246	126	7.58	171	29	BDL	4.5	0.25	0.097			5.548
3/27/02	12:12	10.47	87	7.5	228	117	8.4	102	29	BDL	5.9	0.28	0.16	<20	<20	7.6665
4/9/02	12:00	10.88	99.8	11.5	211	110	9.3	24.8	11	BDL	BDL	0.091	0.031	<20	<20	1.847
4/24/02	8:34	10.21	71.4	3.8	244	123	7.32	18.9	9	BDL	BDL	0.097	0.038			1.7725
5/1/02	11:00	10.97	108	14.6	255	135	7.82	9.3	4	BDL	BDL	0.082	0.041	<20	<20	0.9705
5/20/02	10:17	9.16	89.2	14.1	352	186	8.02	6.6	5	BDL	BDL	0.11	0.062	500	500	0.403

ockney Creek
TCC-3

DATE		TCC3-DO	TCC3-SAT	TCC3-TEM	TCC3-CON	TCC3-TDS	TCC3-PH	TCC3-TUR	TCC3-TSS	TSS1-NH3	TCC3-NN	TCC3-TP	TCC3-OP	TCC3-FC	TCC3-EC	TCC3-Q
Date	**Time**	**D.O.**	**% Sat**	**Temp**	**Cond**	**TDS**	**pH**	**Turbidity**	**TSS**	**NH3**	**NO2+NO3**	**TP**	**OP**	**F-Coli**	**E-Coli**	**Flow**
		(ppm)		(oC)	(uS)	(mg)		(NTU)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	Coli/100mL	Coli/100mL	(cfs)
5/14/01	11:53	9.16	86.1%	12.4	513.0	268.0	7.97		26.0	0.3	1.9	0.240	0.150	2400	2400	3.92
5/29/01	12:07	11.68	114.0%	14.3	455.0	241.0	8.20	9.5	7.0	BDL	0.9	0.250	0.160	230	230	2.31
6/11/01	12:34	11.30	108.1%	13.3	472.0	251.0	8.39	7.2	7.0	BDL	BDL	0.200	0.140	1100	1100	1.77
6/25/01	11:44	10.38	101.8%	14.5	698.0	373.0	8.15	7.8	9.0	0.2	0.4	0.240	0.180	20.0	20.0	0.85
7/9/01	11:51	7.02	77.1%	20.1	825.0	445.0	7.94	10.9	9.0	BDL	0.6	0.330	0.250	500	500.00	0.32
7/23/01	11:28	7.50	79.2%	17.8	1070.0	584.0	8.30	7.3	7.0	0.1	0.4	0.240	0.170	500.00	500	0.46
8/6/01	12:04	6.96	73.1%	17.7	848.0	457.0	7.94	9.0	9.0	0.1	0.6	0.210	0.160	700	700	0.09
8/21/01	13:31	8.13	79.2%	14.1	642.0	345.0	7.92	11.9	7.0	BDL	1.0	0.160	0.110			0.01
9/4/01	12:05	7.78	74.4%	13.5	594.0	316.0		10.7	15.0	BDL	0.7	0.130	0.090	40	40	0.01
9/24/01	12:02	8.12	74.3%	11.5	819.0	441.0			7.0	BDL	0.9	0.100	0.068	20	20	0.03
10/9/01	12:20	10.88	90.4%	7.2	862.0	440.0	8.30	6.7	6.0	BDL	0.5	0.160	0.140	70	70	0.16
10/22/01	12:13	10.23	85.9%	7.7	819.0	419.0	8.29	5.8	4.0	BDL	0.2	0.130	0.100	20	20	0.28
11/5/01	11:00	12.54	97.8%	4.7	807.0	404.0	7.83	4.37	BDL	BDL	0.4	0.150	0.082	40	40	0.67
11/19/01	11:30	13.50	103.3%	4.1	760.0	382.0	8.01	3.8	5.0	BDL	0.3	0.073	0.063	<20	<20	1.09
12/3/01	10:48	134.80	98.6%	1.6	749.0	364.0	8.00	7.4	5.0	0.2	1.1	0.080	0.061	20	20	1.22
12/17/01	11:45	7.33	51.1%	1	735.0	351.0	8.32	6.1	BDL	BDL	1.5	0.120	0.096	80.00	80.000	1.73
1/3/02	11:27	12.86	88.1%	0.1	715.0	339.0	7.84	7.8	8.0	BDL	1.7	0.130	0.100	130.00	40.000	1.04
1/14/02	11:00	13.43	92.6%	0.3	715.0	348.0	8.25	18.0	20.0	BDL	6.9	0.180	0.130			2.91
1/28/02	11:45	9.52	65.3%	0.1	1068.0	552.0	7.85	12.3	9.0	BDL	3.7	0.110	0.100	20.00	20.000	2.18
2/11/02	11:30	10.39	73	0.6	366	179	7.92	12.6	5	BDL	3.3	0.15	0.11	<20	<20	3.3248
2/25/02	12:00	12.51	86.1	0	289	137	6.95	35.2	32	BDL	9.9	0.25	0.18	70.00	70.000	2.3435
3/14/02	15:06	12.91	94.9	2.6	366	179	7.94	54.6	30	BDL	9.6	0.26	0.17			11.274
3/27/02	13:50	10.7	83.1	7.1	297	124	7.95	124						170.00	170.000	26.538
4/9/02	13:36	9.91	86.1	9.1	0.57	188	8.2	21.5								7.1795
4/24/02	9:37	11.26	88.2	5	378	188	8.13	14.3	8	BDL	2.7	0.08	0.041			6.75
5/1/02	12:32	14.44	135.6	12.5	462	190	8.45	10.3	10	0.19	2.1	0.12	0.07	20.00	20.000	3.846.75
5/20/02	12:15	11.8	113.7	13.6	403	211	8.15	11.7	8	BDL	0.23	0.13	0.077	1600	1600	1.66

Shebang Creek
TCC-4

DATE		TCC4-DO	TCC4-SAT	TCC4-TEMI	TCC4-CONI	TCC4-TDS	TCC4-PH	TCC4-TURE	TCC4-TSS	TSS1-NH3	TCC4-NN	TCC4-TP	TCC4-OP	TCC4-FC	TCC4-EC	TCC4-Q
Date	**Time**	**D.O.**	**% Sat**	**Temp**	**Cond**	**TDS**	**pH**	**Turbidity**	**TSS**	**NH_3**	**NO_2+NO_3**	**TP**	**OP**	**F-Coli**	**E-Coli**	**Flow**
		(ppm)		(^{o}C)	(uS)	(mg)		(NTU)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	Coli/100mL	Coli/100mL	(cfs)
5/14/01	12:30	10.51	101.2%	13.60	352.00	183.00	7.90		10.00	0.16	0.19	0.15	0.06	5000.00	5000.00	0.92
5/29/01	11:14	9.84	98.2%	15.40	363.00	194.00	7.94	8.95	8.00	BDL	0.36	0.16	0.05	3000.00	1700.00	0.21
6/11/01	11:55	10.30	104.5%	16.20	353.00	188.00	8.18	6.53	BDL	BDL	BDL	0.10	0.03	3000.00	1700.00	0.22
6/25/01	11:26	9.99	107.7%	17.70	528.00	284.00	7.96	7.21	15.00	0.14	0.28	0.17	0.06	20.00	20.00	0.07
7/9/01	11:31	5.60	66.4%	23.80	617.00	334.00	7.72	30.40	64.00	BDL	BDL	0.35	0.10	300.00	300.00	0.01
7/23/01	11:01	6.25	67.9%	18.80	815.00	439.00	7.90	5.37	9.00	0.13	BDL	0.15	0.04	230.00	80.00	0.06
8/6/01	11:35	2.64	27.9%	18.60	652.00	352.00	7.55	9.97	12.00	BDL	BDL	0.16	0.05	20.00	20.00	0.00
8/21/01	12:52	2.05	21.0%	17.00	476.00	254.00	7.34	10.60	8.00	BDL	BDL	0.12	0.05			0.00
9/4/01	11:40	4.06	40.4%	4.80	464.00	249.00	7.31	2.24	700.00	BDL	BDL	1.50	0.05	500.00	500.00	0.00
9/24/01																0.00
10/9/01	12:00	8.29	68.9%	7.40	589.00	303.00	8.30	5.73	5.00	BDL	BDL	0.05	0.02	700.00	700.00	0.06
10/22/01	11:54	10.19	86.2%	8.10	607.00	312.00	8.72	3.47	BDL	BDL	BDL	0.05	0.02	130.00	80.00	0.06
11/5/01	10:46	11.21	86.2%	4.30	573.00	288.00	7.58	3.03	BDL	BDL	0.41	0.04	0.02	<20	<20	0.18
11/19/01	11:05	12.34	93.0%	3.50	550.00	277.00	7.80	2.55	BDL	BDL	0.44	0.03	0.02	110.00	110.00	0.14
12/3/01	10:26	12.33	86.4%	0.90	550.00	270.00	8.76	3.45	BDL	0.18	0.97	0.03	0.01	20.00	20.00	
12/17/01	11:15	14.29	100.5%	1.00	544.00	261.00	8.36	3.42	BDL	BDL	1.10	0.06	0.04	80.00	80.00	0.4076
1/3/02	11:00	11.54	79.3%	0.20	571.00	273.00	8.14	5.04	BDL	BDL	1.50	0.10	0.07	1700.00	1700.00	0.57
1/14/02	10:45	13.11	90.3%	0.20	457.00	224.00	8.60	6.70	6.00	BDL	6.70	0.08	0.05	170.00	170.00	1.81
1/28/02	11:26	7.66	52.6%	0.20	528.00	267.00	8.14	10.20	13.00	BDL	2.00	0.09	0.04	70.00	70.00	1.36
2/11/02	11:00	10.66	73.9	0.50	341.00	166.00	7.11	15.10	9.00	BDL	3.10	0.18	0.04	500.00	170.00	2.59
2/25/02	11:15	12.81	88	0.10	289.00	137.00	6.95	35.20	11.00	0.28	8.50	0.32	0.23	300.00	300.00	8.57
3/14/02	14:47	12.73	95.2	3.30	224.00	111.00	7.94	44.20	14.00	BDL	8.10	0.21	0.14			12.07
3/27/02	13:30	10.04	84.1	7.60	178.00	91.00	7.90	103.00	58.00	0.10	6.10	0.34	0.20	1100.00	1100.00	24.89
4/9/02	13:07	9.22	84.1	11.30	207.00	108.00	8.20	19.60	29.00	BDL	2.80	0.11	0.05	230.00	230.00	3.68
4/24/02	9:26	10.94	84.3	4.40	234.00	117.00	8.04	14.10	5.00	BDL	1.70	0.09	0.03			2.40
5/1/02	12:08	13.28	132.5	15.30	229.00	121.00	8.49	8.28	6.00	BDL	0.32	0.09	0.03	40.00	40.00	1.24
5/20/02	11:37	9.35	90.5	14.00	310.00	163.00	7.70	17.50	10.00	BDL	BDL	0.13	0.03	>1600	>1600	0.25

Appendix B. Quality control/ quality assurance data for all analytical parameters studies during the TCC project. Simple linear regreassion was used to assess the strength of each duplicate sample.